Model RM-19

Radiation Monitor Technical Manual

8-83
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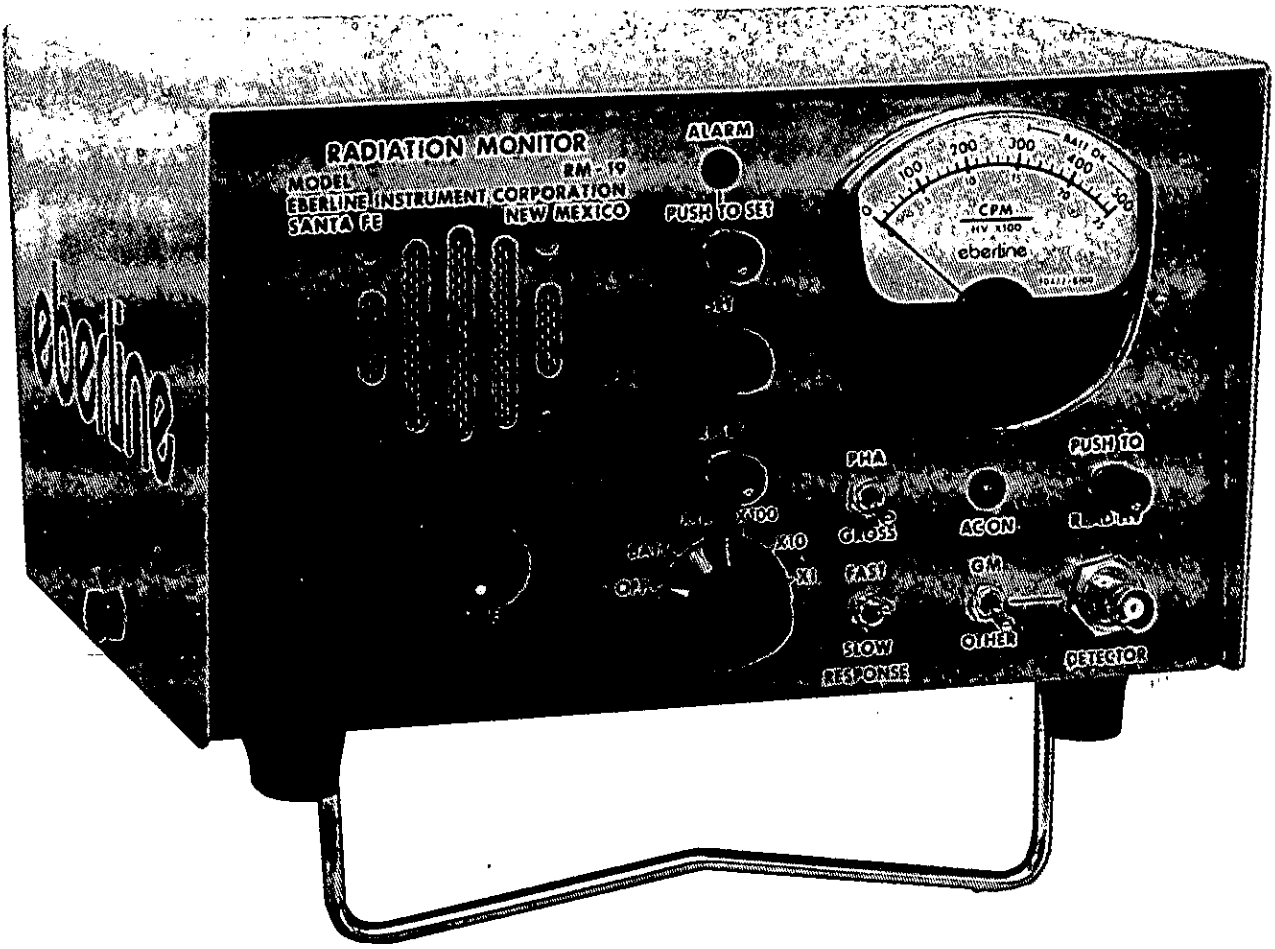


Figure 1-1. Radiation Monitor, Model RM-19

SECTION I

GENERAL

A. PURPOSE AND DESCRIPTION

The RM-19 is a small, versatile alarming count rate meter with a charge sensitive input circuit and a single channel pulse height analyzer (PHA) for use with any Eberline detector. It is operated from a Gel-Cell® battery which is float charged when the unit is plugged into an AC line. Four meter ranges are provided of 500, 5k, 50k and 500k counts per minute (cpm) full scale; and a speaker with volume control provides aural indication of the count rate.

The alarm controls are located on the front panel. A PUSH-TO-SET alarm switch allows the alarm point to be located on the meter directly and an ALARM SET control allows the alarm point to be adjusted from zero to greater than full scale. When actuated, the alarm does not affect the meter reading and is indicated by a red light and a high frequency tone on the speaker.

The detector high voltage is adjustable over a wide range by a rear panel control. This allows setting the proper operating voltage of a G-M tube, scintillation detector or a gas proportional detector. The high voltage setting may be viewed on the meter by actuating the PUSH-TO-READ high voltage switch. The high voltage adjustment, along with the threshold and window controls, sets the energy level being counted when in the PHA mode.

Circuitry in the RM-19 is all solid-state. The top cover is easily removed for access to internal components. Rear panel connectors are provided for an external scaler and a 50 μA DC recorder or remote meter.

B. SPECIFICATIONS

1. Meter

a. Scale Length: 2.37 inches (6.02cm).

b. Scale Markings: 0-500 cpm with 25 increments, BATTery OK segment, high voltage scale marked 0-2500 V in 100 V increments.

c. Range: Switch controlled multipliers of 1, 10, 100 and 1k yielding 500, 5k, 50k and 500k cpm full scale.

2. Response: Fast, 2 seconds; slow, 20 seconds, measured to 90% of final reading.

3. Linearity: Within 5% of full scale, typically within 2% or full scale.

4. Battery Dependence: Calibration shifts less than ±10% between battery operating limits.

5. Alarm Point: Adjustable from 0 to greater than full scale, front panel adjustable and is displayed on meter when the PUSH-TO-SET alarm switch is actuated.

6. Alarm Indication: Red light on front panel and approximately 1 kHz tome on speaker independent of volume control.

7. Speaker: 2 inch size. One click for each event counted.

8. High Voltage: Adjustable from less than 500 V to 2500 ±10% V (if detector load is negligible) by rear panel High Voltage ADJUST. Less than 40 V change between battery operating limits.

9. Input Sensitivity: Adjustable by internal control from approximately 2 x 10^{-14} to 3 x 13^{-13} C (approximately 1-15 mV equivalent on voltage sensitive input).

10. Threshold: Adjustable from 0 to 1 volt.

11. Window: Adjustable form 0 to 1 volt always constant above threshold. A GROSS-PHA switch provides gross counting by disabling the window.

12. Power: 105-125 V 50-60 Hz at approximately o.1 A.

13. Battery: Lifetime without recharge approximately 50 hours, charging time approximately 50 hours. Lifetime approximately 8 hours with alarm on.

14. Temperature: The instrument is operational from -20°F to +140°F (-29°C to 60°C) with less than ±10% of full scale change in calibration or alarm point. The typical change in high voltage over this range is less than ±5%.

15. Outputs

a. Scaler Out: Rear panel, BNC connector. One 2 V positive pulse for each event counted.

b. Recorder Out: Rear panel, 1/4 inch 3-wire phone plug, 0-50 μA DC full scale.

16. Detector Connector: MHV series coaxial connector.

17. Mechanical

   a. Size

      (1) Height: 6 inches (15.2 cm).

      (2) Depth: 9 inches (22.9 cm).

      (3) Width: 9-3/8 inches (23.8 cm).

   b. Weight: 6 pounds 2 ounces (2.8 kg).

18. Detector Requirements: The detector must operate from positive high voltage and have a single coaxial type connection. Scintillation detectors must have a minimum DC resistance of 100 MΩ and operate with between 500 and 1800 V applied. Detectors with negligible DC loading (G-M, gas proportional, etc.) must operate with between 500 and 2500 V applied.

19. PHA: To use the PHA feature the amplitude of the output pulses from the detector must be proportional to the energy of the radiation and vary with the high voltage applied.

Any detector that meets the requirement for PHA will also work for gross counting.

SECTION II
OPERATION

A. DESCRIPTION OF CONTROLS AND CONNECTORS

1. External (Figures 1-1 and 2-2)

a. SWITCH: Six position switch turns instrument OFF, checks BATTery condition, and selects scale multipliers of 1, 10, 100 and 1k. This number must be multiplied by the meter reading to obtain the proper count rate.

b. VOLUME: Varies speaker clicks from maximum loudness to zero.

c. PUSH-TO-SET: Allows the alarm set point to be displayed on the meter.

d. SET: Adjusts the alarm set point.

e. RESET: Resets the alarm and causes the meter reading to return to zero.

f. PHA-GROSS: Switch selects either PHA (pulse height analyzer) or GROSS operation.

g. FAST-SLOW RESPONSE: Switch selects either fast or slow instrument response.

h. GM-OTHER: Switch selects whether the RM-19 is to be used with a G-M detector or some other type of detector.

i. DETECTOR: Connection to detector. MHV series coaxial.

j. PUSH-TO-READ HV: Allows the high voltage reading to be displayed on the meter.

k. HV ADJUST: Pot to adjust the high voltage according to the use of the instrument.

l. SCALER OUTPUT: BNC series coaxial. Connection to external scaler.

m. RECORDER: Connection for external 50 μA recorder.

2. Internal (Figure 2-1)

a. CALIBRATION CONTROLS: One control for each range which individually calibrates that range to agree with the input count rate. Multi-turns pots located on the printed circuit board.

b. GAIN Adjust: Two controls located on the printed circuit board. One is a variable capacitor with a large adjustment range and the other is a multi-turn pot for a smaller amount of gain control.

c. THSH (Threshold): Multi-turn pot to control the threshold level. Adjustable from 0 to 1 volt.

d. WIN (Window): Multi-turn pot to control the window width when using the instrument in the PHA mode. Adjustable from 0 to 1 volt always constant above the threshold.

e. HV CAL: Multi-turn pot for calibrating the high voltage meter reading to correspond to the high voltage.

B. PREPARATION FOR USE

1. Inspection

The instrument should be checked for physical damage.

2. Connections

NOTE

> Before using the instrument for the first time and before changing to a different type of detector, follow the instructions in the Maintenance Section, IV, C, 4 or 5 to avoid damaging the detector.

a. Connect the cable to the instrument and the detector to the cable.

b. Plug the AC cord into a 115 V, 60 Hz line. AC ON light should light.

C. USING THE INSTRUMENT

1. Starting

Turn the switch to BATTery check. The meter should indicate in the BATT OK area.

2. Operation Check

With the PHA-GROSS switch in GROSS position and the range switch on the appropriate range, place a check source in a repeatable position adjacent to the detector to achieve an upscale reading. Note that the reading is sensitive to the position of the source. The reading may be recorded for future reference.

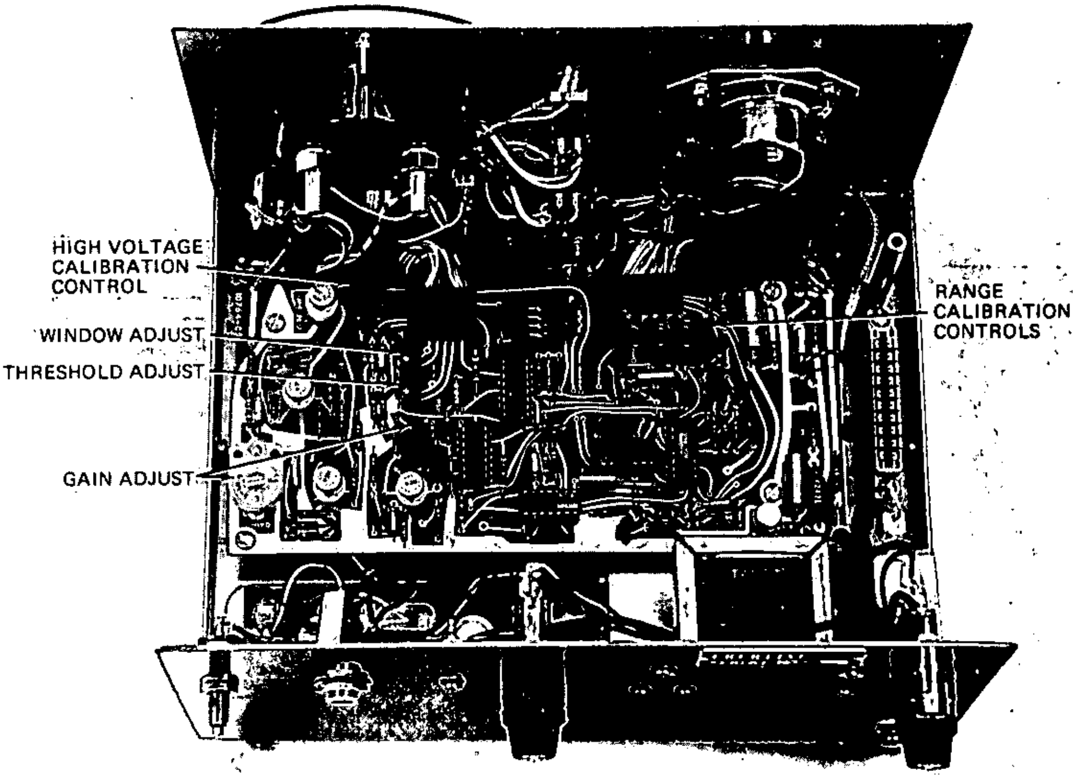


Figure 2-1. Top View, Cover Removed

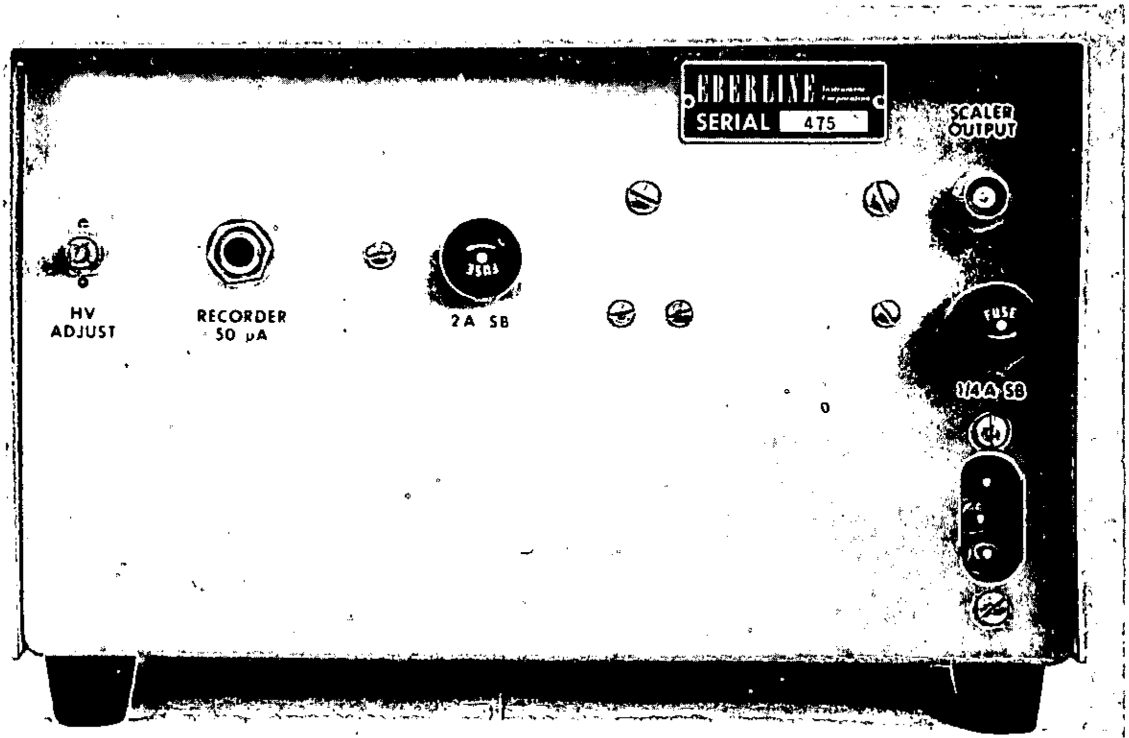


Figure 2-2. Rear View, Cover in Place

Push the RESET button and the reading should drop to zero rapidly, then climb back to source reading when RESET is released. The RESPONSE switch may be selected for the best compromise between speed of reading and meter fluctuation.

Rotate the ALARM SET counterclockwise until alarm occurs. Alarm light should light and 1000 Hz squeal will be heard on the speaker. Push the RESET button; the alarm condition should go away until reading exceeds ALARM SET point.

3. Interpretation of Indications

The meter reading must be multiplied by the scale switch setting to obtain the proper number. The fluctuation of the meter is normal and is caused by the random nature of radioactive decay.

SECTION III
THEORY OF OPERATION

A. GENERAL

The high voltage supply develops high voltage for the detector. When radiation reacts in the detector, negative pulses are generated. These pulses are coupled into an amplifier.

After amplification, the pulses are applied to a pulse height analyzer, which can be disabled for gross counting.

The output of the pulse height analyzer is coupled to a trigger circuit, and the trigger converts these pulses to standard width pulses. These standard pulses are applied to the meter driver which converts them to standard pulses of current, averages this current, and drives the meter. Thus the meter reading is proportional to the average rate of radiation at the detector.

The voltage across the meter is applied to a comparator whose reference voltage is controlled by the ALARM SET control. When the meter voltage exceeds the reference voltage, the circuit sustains an alarm condition which lights the alarm light, turns on the alarm oscillator and couples its frequency to the speaker.

B. FUNCTIONAL THEORY

1. High Voltage Supply

This unit consists of a controlled oscillator (Q101), voltage step-up and rectification (T101), high voltage division (R 106, R107, R108, R109 and R112), differential amplifier (Q104, Q105, Q106), amplifier (Q103) and oscillator control (Q102).

The regulation circuit is in balance when the voltages on Q104 gate and Q105 gate are equal. The high voltage will be a multiple of the voltage on the gates, approximately 800 times. The high voltage is varied by varying the voltage on the reference side (gate Q104) with R10, HV ADJUST As the reference is increased, the differential amplifier is unbalanced, which increases the level of the oscillator and the high voltage output. This puts more current through the high voltage reference resistors, increasing the voltage on the sensing input (Q105 gate), and rebalances the circuit at a higher voltage.

A heavier load tends to lower the high voltage, unbalancing the differential amplifier. This increases the level of the oscillator, to maintain the original output.

Changes in power supply input voltage are compensated by R110.

The differential amplifier is a matched pair (Q104, Q105) for temperature stability. Q106 is a current source.

2. Amplifier

The amplifier consists of A201, A202, A203 and associated circuitry. A201 is a charge sensitive amplifier whose output is controlled by the GAIN capacitor C201. CR202 is a protection diode and C203 is a frequency compensation capacitor. R201, R202, R203 and C207 are a biasing network designed to keep the amplifier in a linear operating region. A202 is an amplifier inverter. C204 is a frequency compensation capacitor. R204, R215, R216 and C208 are a biasing network used to maintain A202 in a linear operating region. A203 is an inverter-amplifier. R220 is a variable GAIN control. C205 is used for frequency compensation. R222, R223 and C210 are a biasing network to maintain A203 in a linear operating region. S7, the GM-OTHER switch, and CR203 are used to switch the amplifier from a very high gain to low gain so that a G-M detector may be used when the amplifier is adjusted to be used with a detector that requires a high sensitivity without changing the amplifier gain settings.

3. Pulse Height Analyzer

The pulse height analyzer consists of A301, A303, A304 and their associated circuitry.

A301 is a quad comparator whose control levels are adjusted by R330 (THRESHOLD) and R326 (WINDOW). The lower level of the window discriminator is connected to the threshold lower level so that the window always is constant above the threshold. The discriminators trigger on the trailing edge of the input pulse so that the window output occurs before the threshold output if the window level is exceeded. The outputs of the discriminators are fed to A303 which is a Dual D flip-flop. A303 is used for pulse shaping and sure triggering. S2 (PHA-GROSS) is used to disable the window part of the Dual D flip-flop for gross counting.

The outputs of the Dual D flip-flop are connected to A304 which is a quad two input NOR gate. Here the pulses from the Dual D flip-flop are compared and if one exists from the threshold and not from the window then an output from the NOR gate is obtained. If both a window and a threshold pulse exist, then no output is obtained.

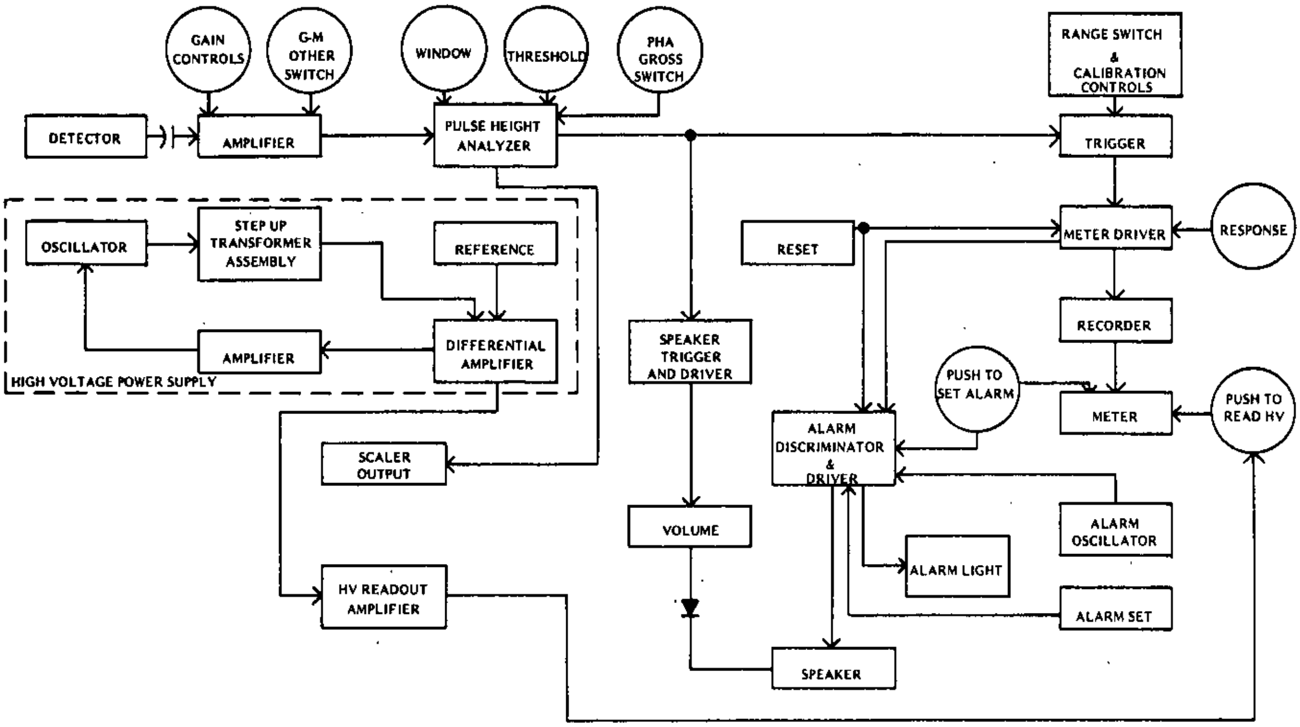


Figure 3-1. System Block Diagram

When a threshold pulse is obtained an output is obtained from the threshold flip-flop (Q) that is fed to another gate input on A304 through a pulse shaping network R305, CR301 and C307. The output from the NOR gate is fed back to the CD input on the Dual flip-flop to reset it.

4. Trigger Circuit

The trigger circuit consists of A 305 and its associated circuitry. A305 is a dual monostable multivibrator of which one-half is used for the meter circuit trigger. The multivibrator's output pulse width is controlled by the RC time constant at pins 1 and 2. This time constant is established by the setting of S1A (scale switch) which selects a particular R and C. The calibration controls (R331, R332, R333 and R334) form the R for each range, making the pulse width continuously variable for calibration.

When the trigger is initiated the output goes positive and remains so until the predetermined time (RC) elapses.

5. Meter Driver

The meter driver Q303 is normally off, so no current flows through the meter M1. When the trigger is on, Q304 is turned on and current flows. The amount of current is determined by the voltage on the base of Q304 and R309. The length of time current flows is determined by the trigger pulse width. This (current times time) forms a certain charge which is transferred to C302 (or C302 and C303, depending on response switch setting) for each event counted. C302 discharges through M1, yielding a certain average current dependent on the rate of input pulses. Changing the pulse width (i.e., changing scales or calibration control settings) changes the average current for a given input pulse rate. This allows the meter to be calibrated to read counts per minute at the detector.

The response time is controlled by the RC time constant of C302, R7 and R2 in the fast position; of C302, C303, R7 and R2 in the slow position.

6. Speaker Driver

The second half of A305 is used to provide a constant pulse width for the speaker circuit. C306 and R315 set the pulse width for the speaker. Q301 and Q302 amplify the speaker pulse and drive the speaker. One click is heard for each event counted. Speaker loudness is controlled by the setting of R3 (VOLUME).

7. Alarm Circuit

The alarm circuit consists of 1/4 of A301, 1/2 of A304, Q305, Q306, Q307, Q308, Q310, DS2 and their associated circuitry.

The meter drive voltage on C302 is applied to Pin 10 of A301 through R312 and across C317 and CR304. R312 and C317 are necessary to prevent loading of the meter drive circuit and to help average out the pulsations for the alarm comparator at low count-rates. Pin 11 of A301 is set to a voltage using R6, the ALARM SET control. This setting may be observed on M1 by pressing the PUSH-TO-SET ALARM (S3) which disengages the meter counting circuitry and engages the ALARM control.

When the voltage on Pin 10 of A301 exceeds that on Pin 11, the output of the discriminator goes low which turns Q305 on. CR302, R324, R321 and Q310 comprise a latching circuit that latches and holds Q305 on once it has been initially turned on even if the alarm condition goes away.

When Q305 is turned on, it causes Q306 and Q308 to be turned on. Q308 drives DS2, the alarm light.

When Q306 is turned on, the oscillator signal from Pin 13 of A304 is fed to the base of Q307 where it is amplified and fed directly to the speaker. The oscillator frequency is determined by C301 and R318. This oscillator frequency determines the alarm tone.

To reset an alarm, S5 (RESET) is pressed, which unlatches the alarm circuitry.

8. Scaler Output

Q311 is an emitter follower which couples the signal from the pulse height analyzer output to a panel connector for driving an external scaler.

9. Power

The AC line voltage is stepped down by T1 and rectified by A1. C401 is a filter capacitor. This voltage is used to float charge BT-1. The voltage on BT-1 is regulated by CR402. Since the line is not switched, the battery will be charging any time the instrument is plugged into the AC line. The AC ON lamp (DS-3) will be on any time the instrument is plugged into the AC line.

The low voltages for the circuitry are regulated by CR403 and A302. C316 is a filter capacitor for CR403.

C. MODIFICATIONS

1. Recorder Ourput

The recorder signal may be changed from 50 μA to 10 mV full scale by adding a 200 Ω resistor across the output terminals.

2. Alarms

The alarm may be made non-locking by removing CR302.

SECTION IV
MAINTENANCE

A. DISASSEMBLY AND REASSEMBLY

1. To remove cover, remove the 10-32 screw from each side of the unit and lift the cover off.

2. To remove the high voltage card, remove the retaining screw and pull the module out.

B. PREVENTIVE MAINTENANCE

1. Keep the instrument clean and dry.

2. Whenever possible, keep the unit plugged into an AC line when not in use.

C. CALIBRATION

1. Calibration Controls (X1, X10, X100, X1K): To calibrate these ranges, a pulse generator such as an Eberline Model MP-1 or equivalent is necessary. Capacitively couple the pulse generator to the DETECTOR connector using a capacitor with a 3KV voltage rating (in lieu of the capacitor, remove the high voltage module). The pulse generator must have a negative pulse whose amplitude is greater than 10 mV with a rise time of less than 1 μsecond, and a frequency range covering that of the instrument.

a. Set the RM-19 RANGE switch at X1K.

b. Select 400,000 cpm from the pulse generator.

c. Adjust the X1K CAL control (R334) for a meter reading of 400.

d. Set the RANGE switch to X100.

e. Select 40,000 cpm from the pulse generator.

f. Adjust the X100 CAL control (R333) for a meter reading of 400.

g. Set the RANGE switch to X10.

h. Select 4000 cpm from the pulse generator.

i. Adjust the X10 CAL control (R332) for a meter reading of 400.

j. Set the RANGE switch to X1.

k. Select 400 cpm from the pulse generator.

l. Adjust the X1 CAL control (R331) for a meter reading of 400.

2. *GAIN*

a. For improved operation, always set and leave *GAIN* control pot R220 in the fully counterclockwise position (minimum gain). If insufficient gain is available from *GAIN* capacitor C201 when the *GM-OTHER* switch is in the *OTHER* position, R220 may

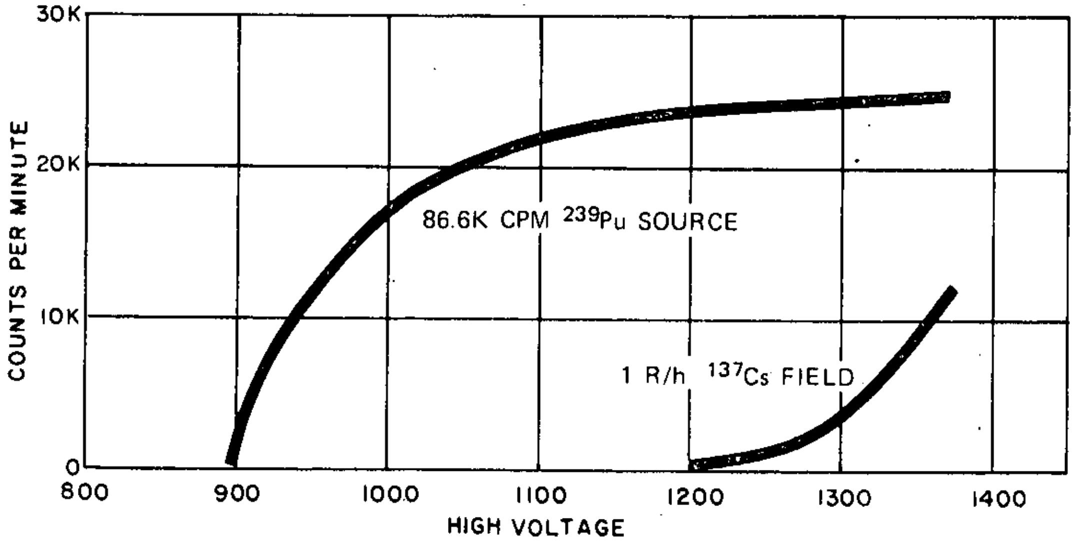


Figure 4-1. Typical AC-3 Response on RM-19

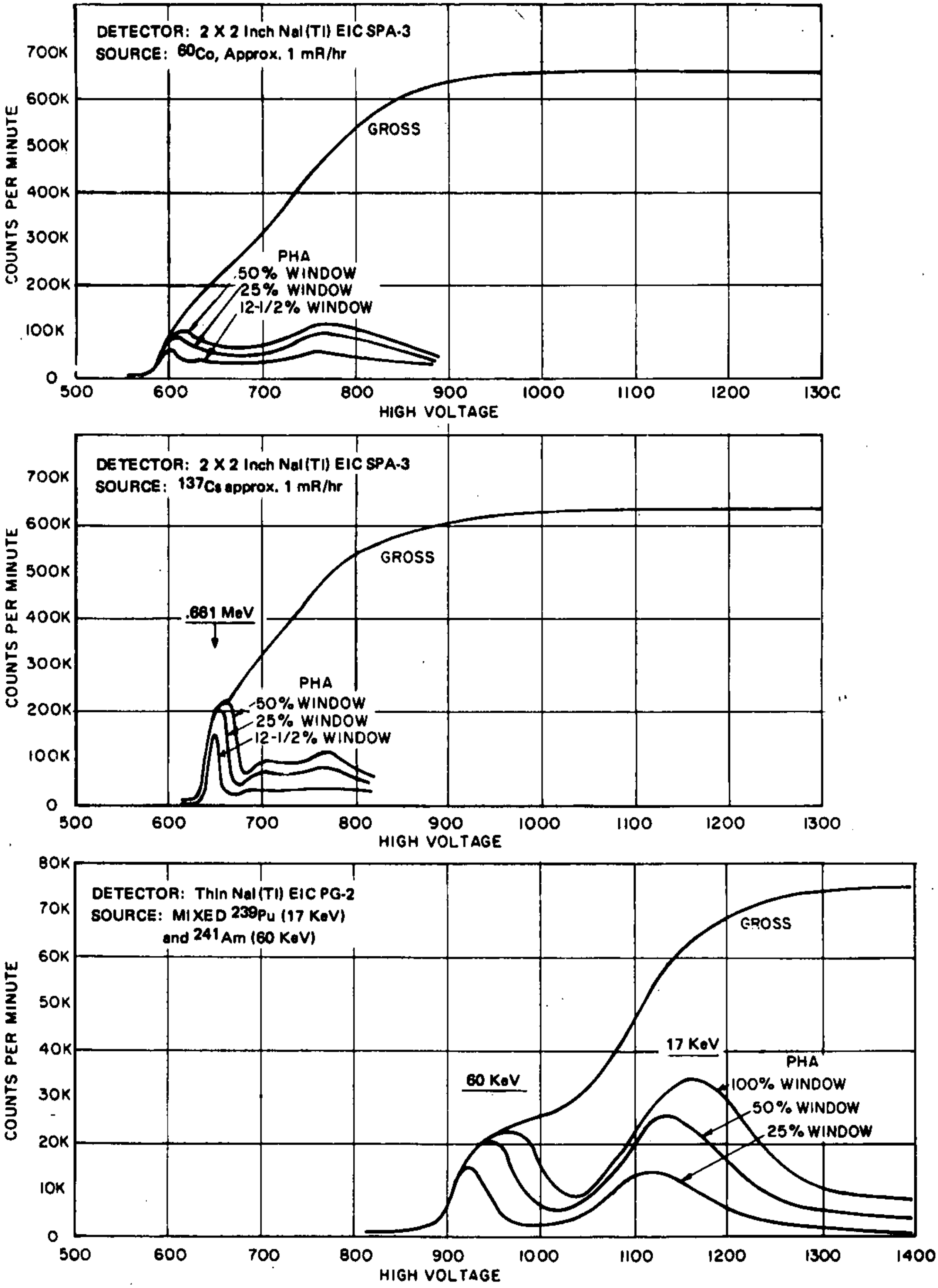


Figure 4-2. Typical RM-19 Response with Gamma Scintillation Detectors

then be used to increase gain if required for proper operation of proportional detectors.

b. The factory setting of input sensitivities for various detectors is now made as follows:

Proportional: 2 mV, *GM-OTHER* switch to *OTHER*.
Scintillation: Approximately 10 mV, *GM-OTHER* switch to *OTHER*.
GM: 300 mV, *GM-OTHER* switch to *GM*.
No Detector Specified: 10 mV, *GM-OTHER* switch to *OTHER*.

To adjust the gain controls, the following procedure may be used:

a. Set the PHA-GROSS switch to GROSS.

b. Adjust the HV ADJust control for a reading of 2 KV on the voltmeter.

c. Set the pulse generator for the desired pulse amplitude (i.e., 6 mV).

d. Adjust GAIN controls C201 and R220 so that the RM-19 just counts the pulse generator.

3. HV CAL

To calibrate the high voltage reading on the meter to true high voltage the following procedure is recommended:

a. Connect an electrostatic voltmeter to the center wire on the high voltage input connector.

b. Adjust the HV ADJust control for a reading of 2 kV on the voltmeter.

c. Push the PUSH-TO-READ HV switch and adjust the HV CAL control (R329) for a meter reading of 2 kV.

4. Gross Counting

With PHA-GROSS switch in GROSS position, connect detector to DETECTOR connector. The proper setting for high voltage is to operate on the detector plateau, below the threshold of noise or unwanted radiation (see Figure 4-1). This setting is best determined as follows:

a. Plot a plateau (cpm vs voltage) with the detector counting the type of radiation of interest.

b. Plot a second plateau with the detector counting the type of radiation to be rejected (i.e., gamma for an alpha detector or normal background reading, as applicable).

c. From the two plateau curves a voltage is picked and the instrument adjusted to that voltage.

CAUTION

The high voltage supply may have a voltage capability exceeding the detector rating. DO NOT turn the High Voltage ADJUST to maximum without observing either noise or plateau.

5. Pulse Height Analyzer Counting

To use the pulse height analyzer feature, the amplitude of the output pulses from the detector must be proportional to the energy of the radiation and vary with the high voltage applied.

a. WINdow Adjustment: The WINdow control adjusts the range of pulse heights that will be counted.

The window width is expressed as a percentage of the threshold which is found by:

$$\frac{\text{Window Width (mV)}}{\text{Threshold (mV)}} \times 100 = \%\ \text{Window}$$

For example, with a threshold of 10 mV, and a 50% window, the window width is 5 mV, and all pulses between 10 and 15 millivolts in amplitude will be counted.

The window width should be optimized to the particular detector and energy of interest. Figure 4-2 will aid in setting % window.

b. High Voltage Setting: Since the pulse height from the detector is proportional to the energy of the radiation at the detector, and high voltage varies the pulse height of the pulses, any energy can be set in the window by high voltage adjustment.

Plot a response curve (cpm vs high voltage, Figure 4-2) exposing the detector to a source of the proper energy which is intense enough to obtain a reading well above background. If background radiation makes the source counting doubtful, it may be verified by removal and replacement of the source. The energy peak can then be identified with a high voltage setting. Note that a higher energy requires a lower high voltage setting and vice versa.

D. TROUBLESHOOTING

Typical voltages and waveforms are given on the schematic (Figure 6-1) and component locations are shown in Figures 6-2 and 6-3.

Voltages are measured with a 20,000 Ω per volt, or greater, voltmeter except the high voltage points. An electrostatic voltmeter or a voltmeter with at least 1000 MΩ input impedance should be used to check the high voltage.

SECTION V
PARTS LIST

The following table lists the mechanical items incorporated in the RM-19 and should contain any part necess ry for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to b sidered typical examples only and not restrictions against using equivalent parts with the same opera characteristics. When ordering parts from Eberline, specify model number, serial number, reference designa value, and Eberline Part No., or a word description if the part has no reference designation. Eberline will automa ly substitute equivalent parts when the one called out by the manufacturers' part number is not available.

REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
1. Overall and Miscellaneous				
	AC Cord	3 wire	Belden 17952	WRAC2
BT1	Battery	8 V, 2.6 Ah, Gel-Cell	Globe-Union GC826-1	BTGC3
2. Chassis				
A1	Bridge Rectifier		Varo VS148	CRARVS0148
C1	Capacitor	Disc Ceramic, 220 pF, 3 kV	Sprague 30GAT22 or equivalent	CPCE221P3Y
C3	Capacitor	0.05 μF, 10%, 3500 V	Capco EBL-1	CPPF503PXY
CR1	Diode		Type 1N4002	CRSI1N4002
DS1	Speaker		Lafayette S-433	ADSP3
DS2	LED	Red *(ALARM)*	Monsanto MV5025	OPLP2
DS3	LED	*AC ON*	Monsanto MV5021	OPLP1
F1	Fuse	3 AG, 1/4 A, S.B.	Littelfuse 313.250	FUSB4
F2	Fuse	3 AG, 2 A, S.B.	Littelfuse 313002	FUSB7
M1	Meter	50 μA dc, with Eberline 10472-B100 Face	Jewell MM-2T	MTPA23
R1	Resistor	255k, 1%, 1/8 W	MIL Type RN60D	REMF254B11
R2	Resistor	4.3k, 1/4 W, 5%		RECC432B22
R3	Potentiometer	50, 2 W, 10%, Linear *(VOLUME)*	Ohmite CMU5001 or equivalent	PTCC500B05
R4	Resistor	15, 1/2 W, 10%		RECC150B23
R5	Resistor	1M, 1/4 W, 10%		RECC105B22
R6	Potentiometer	1k, 10%, Linear *(ALARM SET)*	Allen Bradley WA2G056S102UA	PTCC102B03
R7	Resistor	18k, 1/4 W, 10%		RE183B22
R10	Potentiometer	10k, 1/2 W, 20% *(HV ADJUST)*	RV6LAYSA103A	PTCC103B23
R11	Resistor	27k, 1/4 W, 5%		RECC273B22
R12	Resistor	22k, 1/4 W, 5%		RECC223B22

REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
S1	Switch	Rotary	10545-B05	SWRO31
S2, S4, S7	Switch	Toggle, SPDT	ALCO MTA-1060	SWTO12
S3, S5, S6	Switch	Pushbutton, DPDT	ALCO MSP-205R	SWPB10
T1	Transformer	12 V, 350 mA	Stancor P-8391	TFPO10
	EMI Filter	1 A, 115/230 V, 50-400 Hz	Corcom 1B4	MEVE5
	Connector	Printed Circuit Board, 10 Pins	Viking 2 VK-10S/1-2 or equivalent	SOPC210
3. Electronics Board				
A201, A202, A203, A306,	Integrated Circuit	Operational Amplifier	RCA CA313OT	ICAOC313OT
A301	Integrated Circuit	Quad Comparator	National LM339N	ICACA0339N
A302	Voltage Regulator	5.0 V	National LM309H	ICAVCO309H
A303	Integrated Circuit	Dual J-K Flip-Flop	FSC 9L24DC or 9LS109PC	ICLSA00109
A304	Integrated Circuit	Quad NOR Gate	TI SN74LS02	ICLSA00002
A305	Integrated Circuit	Dual Monostable	FSC 9602PC	ICTTA09602
A307	Integrated Circuit	Transistor Array	RCA CA3096AE	ICRTACA3096E
C201	Capacitor	Variable Ceramic, 5-50 pF	ERIE 503-001 D5-50	CPVA2
C202	Capacitor	0.047 μF at 200 V	Sprague 192P47392	CPPF473P3R
C203	Capacitor	Disc Ceramic, 4.7 pF, 1 kV	Sprague 10TCC-V47 or equivalent	CPCE472F2U
C204	Capacitor	Disc Ceramic, 20 pF, 1 kV	Sprague 10TS-Q20 or equivalent	CPCE200P3U
C205, C311, C318	Capacitor	Disc Ceramic, 68 pF, 1 kV	Sprague 10TSQ68	CPCE680P3P
C206	Capacitor	Disc Ceramic, 0.01 μF, 50 V	Centralab CK-103 or equivalent	CPCE103PXN
C207, C208, C210	Capacitor	3.3 μF, 15 V, 20%, Tantalum	CS13 Case A	CPTA335P3H
C301	Capacitor	0.47 μF, 35 V, 20%, Tantalum	CS13 Case A	CPTA474P3L
C302, C306	Capacitor	33 μF, 6 V, 20%, Tantalum	CS13 Case B	CPTA330M3F
C303	Capacitor	330 μF, 6 V, 20%, Tantalum	CS13 Case D	CPTA331M3D
C304	Capacitor	Disc Ceramic, 0.1 μF, 12 V	Sprague HY-360 or equivalent	CPCE104P3G
C305	Capacitor	0.22 μF, 50 V, Disc Ceramic	Centralab CW30C224M or equivalent	CPCE224P4N
C307	Capacitor	Ceramic, 0.022 μF, 12 V	Sprague HY-340	CPCE223P3G
C308	Capacitor	0.1 μF, 100 V, 10%,	ERIE CK06 BX 104K	CPCE104P3P
C309	Capacitor	0.01 μF, 200 V, 10%,	ERIE CK06 BX 103K	CPCE103P3R
C310	Capacitor	Disc Ceramic, 1000 pF, 500 V	ERIE 801-000X5FO 102K	CPCE102P3X

REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
C312	Capacitor	2.2 μF, 10 V, 20%,	CS13 Case A	CPTA225P3F
C313	Capacitor	0.001 μF, 200 V	Sprague 192P10292	CPPF102P3R
C315	Capacitor	3.3 μF, 50 V, 20%, Tantalum	CS13 Case B	CPTA335P3N
C316	Capacitor	120 μF, 10 V, 20%, Tantalum	CS13 Case C	CPTA121M3F
C317	Capacitor	1.8 μF, 20 V, 20%	CS13 Case A	CPTA185P3I
C401	Capacitor	1.0 μF, 35 V, 20%, Tantalum	CS13 Case A	CPTA105P3L
CR202, CR301-CR305	Diode	Silicon	Type 1N4148	CRSI1N4148
CR203	Diode	Germanium	Type 1N34A	CRGE1N0034
Q301, Q306 Q309	Transistor	NPN	(Reference only — part of A307)	
Q302, Q307	Transistor	PNP	Type 2N4403	TRSP2N4403
Q303, Q310	Transistor	NPN	Type 2N4124	TRSN2N4124
Q304, Q305	Transistor	PNP	(Reference only — part of A307)	
Q308, Q311	Transistor	NPN	Type 2N4401	TRSN2N4401
CR401	Diode	Zener, 9.1 V, 5%, 400 mW	Type 1N757A	CRZR1N0757
CR402	Diode	Zener, 9.1 V, 1%, 5 W	Motorola 5M9. 1ZS1	CRXX2
CR403	Diode	Zener, 6.8 V, 5%, 1 W	Type 1N3016B	CRZR1N3016
R201	Resistor	6.8k, 1/4 W, 10%		RECC682B22
R202, R208, R212	Resistor	5.1k, 1/4 W, 5%		RECC512B22
R203, R204 R216	Resistor	2.7k, 1/4 W, 10%		RECC272B22
R205, R305 R317	Resistor	1.0k, 1/4 W, 10%		RECC102B22
R206	Resistor	470k, 1/4 W, 10%		RECC474B22
R207, R313, R314	Resistor	2k, 1/4 W, 5%		RECC202B22
R209, R213, R324	Resistor	20k, 1/4 W, 5%		RECC203B22
R210, R211, R315, R316, R321, R322, R325	Resistor	10k, 1/4 W, 10%		RECC103B22
R215	Resistor	7.5k, 1/4 W, 5%		RECC752B22
R222	Resistor	16k, 1/4 W, 5%		RECC163B22
R223	Resistor	330, 1/4 W, 5%		RECC331B22
R220, R329, R331, R334	Potentiometer	100k, 25 turns, 0.5 W, Cermet Element	Bourns Model 3299W-1-104	PTCE104B03
R301, R310	Resistor	2.2k, 1/4 W, 5%		RECC222B22

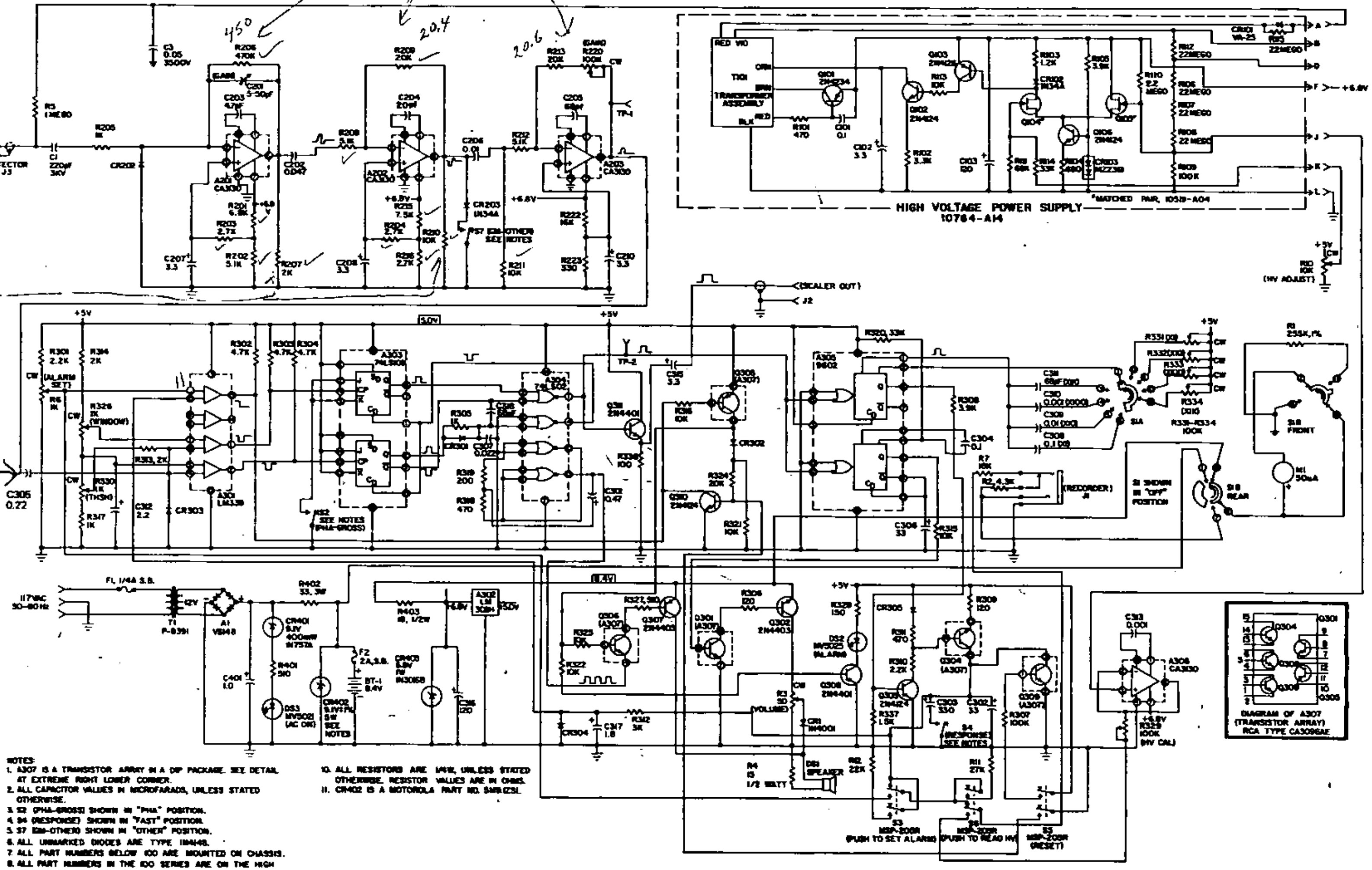
REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
R302, R303, R304	Resistor	4.7k, 1/4 W, 10%		RECC472B22
R306, R309	Resistor	120, 1/4 W, 10%		RECC121B22
R307	Resistor	100k, 1/4 W, 10%		RECC104B22
R308	Resistor	3.9k, 1/4 W, 10%		RECC392B22
R311, R318	Resistor	470, 1/4 W, 10%		RECC471B22
R312	Resistor	3k, 1/4 W, 5%		RECC302B22
R319	Resistor	200, 1/4 W, 5%		RECC201B22
R320	Resistor	33k, 1/4 W, 10%		RECC333B22
R326, R330	Potentiometer	1k, 25 turns, 0.5 W, Cermet Element	Bourns Model 3299W-1-102	PTCE102B03
R327, R401	Resistor	510, 1/4 W, 10%		RECC511B22
R328	Resistor	150, 1/4 W, 10%		RECC151B22
R402	Resistor	33, 3 W, wire wound	Sprague 242E-3305	REWW330B26
R403	Resistor	18, 1/2 W, 5%		RECC180B23
R336	Resistor	100, 1/4, 10%		RECC101B22
R337	Resistor	1.5k, 1/4 W, 5%		RECC152B22
4. High Voltage Supply , 10764-A14 Circuit Board				
C101	Capacitor	0.1 µF, 10%, 80 V	Sprague 192P1049R8	CPPF104P30
C102	Capacitor	3.3 µF, 20%, 10 V	Kemet K3R3C10	CPTA335P3H
C103	Capacitor	120 µF, 20%, 1 V	Kemet K120C10	CPTA121M3F
CR101	Diode	2500 PIV	Varo VA-25	CRSIVA0025
CR102	Diode	Germanium	1N34A	CRGE1N0034
CR103	Diode	Dual Junction	Motorola MZ2361	CRZRMZ2361
Q101	Transistor	PNP	2N4234	TRSP2N4234
Q102, Q106	Transistor	PNP	2N4124	TRSN2N4124
Q103	Transistor	NPN	2N4126	TRSP2N4126
Q104, Q105	Transistor	Matched Pair FET, Selected	10519-A04	TRXX1
R101	Resistor	470, 1/4 W, 10%		RECC471B22
R102	Resistor	3.3k, 1/4 W, 10%		RECC332B22
R103	Resistor	1.2k, 1/4 W, 10%		RECC122B22
R104	Resistor	680, 1/4 W, 10%		RECC681B22
R105	Resistor	3.9k, 1/4 W, 10%		RECC392B22
R106, R107, R108	Resistor	22M, 1/4 W, 5%		RECC226B22
R109	Resistor	110k, 1/4 W, 5%		RECC103B22
R110	Resistor	2.2M, 1/4 W, 10%		RECC225B22
R111	Resistor	68k, 1/4 W, 5%		RECC683B22
R112	Resistor	22M, 1/4 W, 5%		RECC226B22
R113	Resistor	10k, 1/4 W, 10%		RECC103B22
R114	Resistor	33k, 1/4 W, 5%		RECC333B22
R115	Resistor	22M, 1/8 W, 10%		RECC226B21

CRCE224P4N

MODEL RM-19

SECTION VI

DIAGRAMS



NOTES:

1. A307 IS A TRANSISTOR ARRAY IN A DIP PACKAGE. SEE DETAIL AT EXTREME RIGHT LOWER CORNER.
2. ALL CAPACITOR VALUES IN MICROFARADS, UNLESS STATED OTHERWISE.
3. S2 (PHA-GROSS) SHOWN IN "PHA" POSITION.
4. S4 (RESPONSE) SHOWN IN "FAST" POSITION.
5. S7 (GM-OTHER) SHOWN IN "OTHER" POSITION.
6. ALL UNMARKED DIODES ARE TYPE 1N4148.
7. ALL PART NUMBERS BELOW 100 ARE MOUNTED ON CHASSIS.
8. ALL PART NUMBERS IN THE 100 SERIES ARE ON THE HIGH VOLTAGE POWER SUPPLY BOARD.
9. ALL PART NUMBERS IN THE 200, 300 AND 400 SERIES ARE ON THE MAIN ELECTRONICS BOARD.
10. ALL RESISTORS ARE 1/4W, UNLESS STATED OTHERWISE. RESISTOR VALUES ARE IN OHMS.
11. CR402 IS A MOTOROLA PART NO. 5M9.1ZS1.

C305

Figure 6-1. General Schematic of Model RM-19 (10764-D23G)

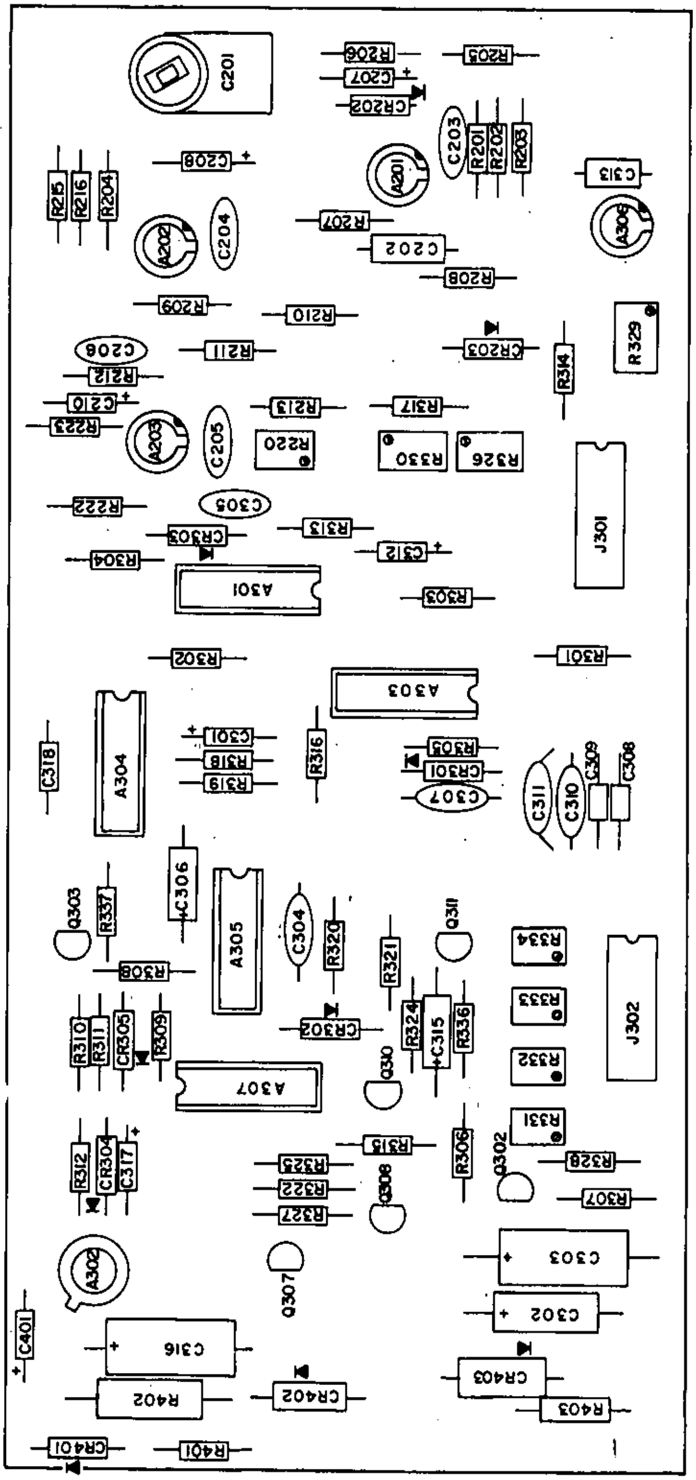


Figure 6-2. Component Layout of Main Printed Circuit Board (10764-C29A)

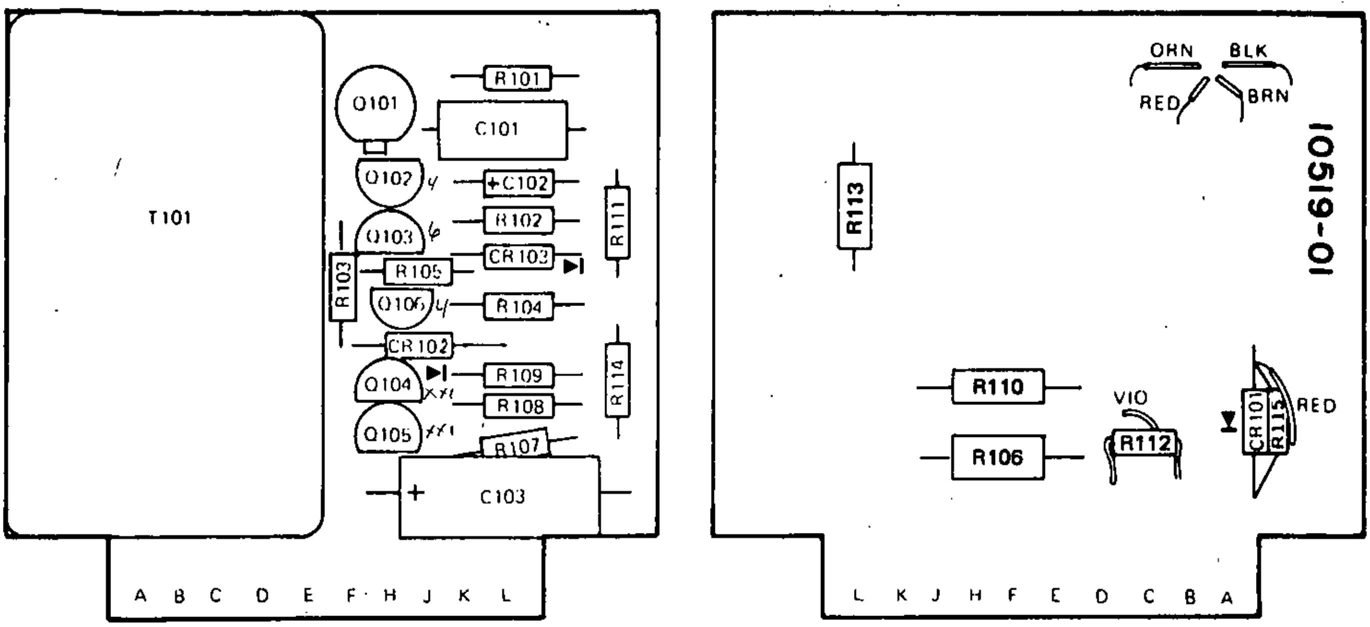


Figure 6-3. Component Layout of High Voltage Power Supply Board